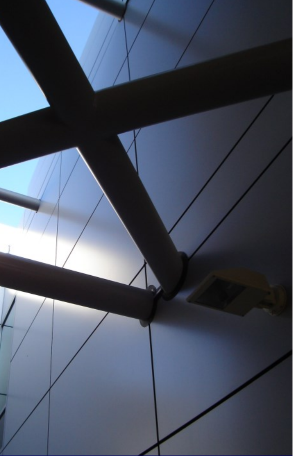

MECHANICAL ENGINEERING

DISSERTATION DEFENSE

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Evander Ramos

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Strain-Based Characterization in Severe Plastic Deformation Processing

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Dr. Suveen Mathaudhu, Chairperson

Scientific innovation is often driven by novel processing capabilities, which enable the production of materials with new and exciting properties. A number of techniques referred to as severe plastic deformation (SPD) have been developed which utilize unprecedented extreme strain conditions to create advanced materials. Such processing has the potential to provide materials solutions to current technological issues humanity faces in areas such as energy, transportation, sustainability, and public health. Additionally, these processes enable exploration of complex microstructures to better understand fundamental relationships between processing, structure, processing, and performance.

The SPD literature consists of many studies reporting the structures and properties garnered from a wide variety of techniques, material systems, and processing conditions. In some cases, reports may be at odds with each other or with expected material behavior, as has been the case for wear resistance and electrical conductivity. For both properties, specific strain-based characterization can improve comparison across the literature to better understand trends and highlight outlier reports in the established literature. For some processes, strain-based investigations may not even be reported, so novel characterization or analysis methods are necessary to enable such comparison across the SPD literature.

In this dissertation, results from experiments on copper subjected to SPD processing has been compared to reports from the literature to identify trends in wear resistance and electrical conductivity across SPD techniques. To accomplish this, novel strain-based analysis and measurement methods have been used for the process of high-pressure torsion. These frameworks of strain-based analysis enabled identification of trends across the SPD literature which has helped to distinguish outlying existing reports and forecast results of previously untested processing conditions. Additionally, the newly enabled strain-based characterization has indicated some trends for SPD wear resistance in relation to strain orientation which had previously gone undetected. To explore this relationship between wear path and strain path, the properties of copper subjected to high-pressure sliding has been explored at different strains and orientations. The microstructural wear response was found to agree with the greater SPD literature as well as the identified strain path dependence indicating that lower wear rates are seen when wear is conducted parallel to the shearing direction. Future works can adapt the comparative analytical frameworks demonstrated in these studies to identify strain-based relationships for other properties, such as magnetism or antibacterial resistance, to inform the development of advanced materials.